Technologies which make geological CO_2 Storage a reality today

Mahmut Sengul[1], Mirella Elkadi[2], Avin Pillay[2], and Colin Francis[2]

[1]Schlumberger Carbon Services, PO Box 21, Abu Dhabi, UAE
[2]The Petroleum Institute, PO Box 2533, Abu Dhabi, UAE
[1]sengul@slb.com, [2]melkadi@pi.ac.ae

1. Introduction

It is generally well known that global warming comes from the build-up of greenhouse gases in the atmosphere. This warming takes place when greenhouse gases (such as CO_2) trap more of the earth's outgoing radiation. Extensive research shows that carbon dioxide in the atmosphere has been increasing over the past century, and the prospect of global warming has become a matter of genuine public concern. The consensus in the scientific community is that most of the increase in CO_2 concentration in the earth's atmosphere arises from the burning of coal, oil and natural gas. Recent reports support the declaration that average air and sea temperatures have increased significantly during the last century [1].

Amongst possible solutions for the reduction of excessive greenhouse gases in the atmosphere is the capture and sequestration of CO_2 in carbonate reservoirs [2,3]. The energy industry is developing expertise in handling and monitoring geologic storage of CO_2 in underground reservoirs. Although storing CO_2 in carbonate reservoirs remains to be further explored [3], it could result in long term mineralization, promising an exceptionally safe solution [4].

The study describes the sequestration of CO_2 by injection into deep aquifers (geologic sequestration) and depleted oil and gas reservoirs. For the long term geologic sequestration of CO_2, solid end products such as $(Ca,Mg)CO_3$ are desirable due to their chemical stability, non-toxic nature and absence of rapid migration [5]. The significance of the chemistry associated with CO_2 solubility in water and oil (solubility trapping) and the reactions of specific substances in water and at rock surfaces will be considered.

2. Key Features

As the concept of geologic sequestration developed, it was recognized that certain salient factors govern the storage of CO_2 in geologic formations. The major factors associated with geologic sequestration of CO_2 are described below. Such sequestration activities should be considered together with enhanced recovery of oil and enhanced natural gas production.

CO_2 capture and storage process

Sequestration in deep saline formations or in oil and gas reservoirs is achieved by a combination of processes: displacement of the *in situ* fluids by CO_2, dissolution of CO_2 into the fluids, and chemical reactions with the minerals present in the formation to form stable solid compounds like carbonates. Displacement dominates initially, but dissolution and reaction become more important over time.

Monitoring CO_2 storage

CO_2 can be trapped as a gas or supercritical fluid under low-permeability cap rock, similar to the way that natural gas is trapped in gas reservoirs. This process is commonly referred to as hydrodynamic trapping, and is likely to be the most important mechanism for sequestration. Mobility of CO_2 requires monitoring and verification. Briefly, monitoring issues involve influence of CO_2 injection on properties of reservoir and cap rocks; long-term sealing integrity of wells; integrated simulation; and time lapsed seismic and electromagnetic surveys. If CO_2 were to be used as a basis for emissions trading or to meet national commitments on emissions reduction, it would be necessary to verify the quantities of CO_2 stored.

Chemical interactions

Solubility involves the dissolution of CO_2 into the reservoir fluids. CO_2 can dissolve into the fluid phase which consists of water and oil. This mechanism is referred to as solubility trapping, and lowers the viscosity and swells the oil which provides the basis for enhanced oil recovery (EOR). On the other hand, mineral trapping involves the reaction of CO_2 with the minerals present in the host formation to form stable solid compounds, such as carbonates. CO_2 can react either directly or indirectly with the minerals and organic matter in the geologic formations to become part of the solid mineral matrix. Aquifers associated with igneous rocks such as basalt are good candidates for sequestering CO_2. An example of such a reaction is: $Mg_2SiO_4 + 2CO_2 \rightarrow 2MgCO_3 + SiO_2$. Solubility and mineral trapping mechanisms are most important especially in the case of an aquifer with no lateral seals.

Risk assessment

Safe and secure storage of CO_2 is the key requirement of this technology. For such operations, safety has been achieved by risk management systems that make use of information from site characterizations, operational monitoring and scientific and engineering experience. Elements of risk management are: safety assessment methodology; long-term monitoring; and public perception and involvement. Environmental and human health risks are of utmost concern. The impact of large catastrophic leaks and slow migration and accumulation are being studied to handle and control CO_2 with adequate safety and certainty.

3. Conclusions

Geologic sequestration of CO_2 is a promising development. It is considered an environmentally safe solution. CO_2 capture and storage offers important possibilities for making further use of fossil fuels more compatible with climate change and mitigation policies. The ability to predict CO_2 releases and their characteristics in any given geologic and geographical setting has become far more challenging. The energy industry is developing expertise to meet this challenge.

In addition, the development and implementation of sound regulatory and legal frameworks tends to build confidence that the operation of CO_2 capture and storage can be done in a safe and secure manner. Public perception and involvement play a major role in any new initiative. An informed public is vital to establish success in the reduction of CO_2 emissions and the implementation of sequestration activities.

4. References and Bibliography

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Author Biographies

Mahmut Sengul has wide expertise in carbon management. He is Vice President of Schlumberger Carbon Services in the Middle East and Asia.

Mirella Elkadi is an Assistant Professor in Chemistry at the Petroleum Institute (PI), Abu Dhabi, UAE. A member of the Royal Society of Chemistry (1995-2005), her areas of interest include organic and environmental chemistry.

Avin Pillay is an Associate Professor in Chemistry at the PI, with interests in analytical/environmental chemistry. He is a member of the Editorial Board of the International Journal of Environmental Studies.

Colin Francis is a Professor and Coordinator of Chemistry at the PI. He is a member of the Royal Society of Chemistry, and his interests include inorganic chemistry and environmental science.